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Annual seasonal variations in relative seismic velocity changes in the Northern Volcanic Zone, Iceland

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We have measured consistent annual seasonal changes in the seismic velocity (dv/v) of the upper Icelandic crust of the order of 0.1%. Changes in dv/v in the shallow crust using ambient seismic noise are being used increasingly as a monitoring tool in volcanic regions in an attempt to identify pre-eruptive changes. To recognise changes due to volcanic processes, it is crucial to identify any background environmental signals. We use data from more than 70 broadband seismometers recorded since 2007 across Iceland's Northern Volcanic Zone. We filter between 0.1 - 1.0 Hz and cross-correlate day-long seismic traces between pairs of seismometers. Then the cross-correlation functions are stacked and small changes in arrival times are measured using the Moving-Window Cross-Spectral method. This corresponds to variations in seismic velocity (dv/v) between the pairs of seismometers in approximately the top 2 km of the crust. Variations in dv/v with depth are investigated by measuring dv/v in different frequency bands. The seasonal variations are also compared to existing studies of surface deformation and forcing mechanisms such as snow/ice loading and temperature changes are investigated. This work is an important observation for monitoring efforts in Iceland, particularly as seasonal trends may mask volcanic signals without appropriate processing. Major volcanic events occurred during this period of study, such as the 2014-15 Bardarbunga-Holuhraun rifting episode. It is significant that any changes in dv/v associated with the 2014-15 rifting and dyke intrusion are subtle or absent, so the annual cycle in dv/v caused primarily by snow loading is dominant.